

Did life exist on Mars? Search for organic and inorganic signatures, one of the goals for “SAM” (sample analysis at Mars)

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Abstract

Observation of Mars shows signs of a past Earth-like climate, and, in that case, there is no objection to the possible development of life, in the underground or at the surface, as in the terrestrial primitive biosphere. Sample analysis at Mars (SAM) is an experiment which may be proposed for atmospheric, ground and underground in situ measurements. One of its goals is to bring direct or indirect information on the possibility for life to have developed on Mars, and to detect traces of past or present biological activity. With this aim, it focuses on the detection of organic molecules: volatile organics are extracted from the sample by simple heating, whereas refractory molecules are made analyzable (i.e. volatile), using derivatization technique or fragmentation by pyrolysis. Gaseous mixtures thus obtained are analyzed by gas chromatography associated to mass spectrometry. Beyond organics, carbonates and other salts are associated to the dense and moist atmosphere necessary to the development of life, and might have formed and accumulated in some places on Mars. They represent another target for SAM. Heating of the samples allows the analysis of structural gases of these minerals (CO₂ from carbonates, etc.), enabling to identify them. We also show, in this paper, that it may be possible to discriminate between abiotic minerals, and minerals (shells, etc.) created by living organisms.

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1. Introduction

In 2009, NASA will probably send a lander/rover to Mars (Mars Science Laboratory, MSL); the aim of the scientific payload of this mission will be, in particular, to search for the presence of extinct or extant traces of life, or prebiotic chemistry that could have existed. It will use a drilling system able to attain depths of some decimeters to meters, and, consequently, will be able to sample zones where inorganic material may be a witness of

epochs where Mars atmosphere was able to ensure the development of life, and where organic remnants might have been preserved from destruction (McKay et al., 1992; Brack et al., 1999). The SAM project that we foresee to present as a part of the scientific payload uses the knowledge that we have acquired in developing analog experiments on other space missions (to Titan, to Jupiter, to comets).

Carbonates, as observed in the SNC-Martian meteorites (Gooding, 1992), have not been fully confirmed at the surface of Mars, nevertheless some observations (Pollack et al., 1990; Lellouch et al., 2000) show that one can hope to find them in the underground (Fonti et al., 2001), even if they may have been destroyed at the

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